Borough of Chambersburg, PA

Technical Requirements Covering Renewable Inverter-Based Customer Generators of 10 Kilowatts or Less and Interconnected with the Borough of Chambersburg Electric System

Revised
November 16, 2010

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The requirements contained herein are in addition to, but do not modify nor negate, the terms of the Borough's "*Net Metering Rider For Renewable Inverter-Based Customer Generators of 10 Kilowatts or Less" ("*Rider*")* and *"Net Metering Interconnection Application/Agreement for Qualifying Renewable Energy Generation (Certified Inverter-Based Units of 10 Kilowatts or Less)"("*Application/Agreement*").* The Borough reserves the right, in its sole discretion, on appropriate public notice, to change the conditions of these Technical Requirements.

1. Purpose - The purpose of this document (relating to interconnection of a renewable energy generation facility) is to clearly state the technical requirements that govern its interconnection and parallel operation, in order to:

A. Establish technical requirements that will promote the safe and reliable parallel operation of QREG facility resources; and
B. Enhance the reliability of electric service.

2. Applicability - These guidelines apply to all customer renewable energy generation of 10 kW or less that utilize inverter-based technology, interconnects at 600 volts or below and operates in parallel with the Borough Electric System as a Qualifying Renewable Energy Generation ("QREG") facility in accordance with the Borough's Rider and Application/Agreement for same.

3. QREG Facility Warning Labels - The Borough shall provide and install warning labels in prominent locations on the electric meter bases and isolation device(s) ("Customer Owned Generation Disconnect Switch(s)") to notify Borough personnel, emergency personnel and the QREG customer that there is a generating source installed on the customer's side of the meter. The warning labels shall not be placed in a location that interferes with the ability of Borough personnel to read and service the electric meter. The warning labels shall be installed before the QREG facility is interconnected with the Borough Electric System.

4. Connection Approval - The QREG customer may not connect its QREG facility to the Borough Electric System until after the Application/Agreement is approved and the QREG customer has received written approval notification from the Borough. The Borough shall provide notification in a reasonably timely manner following the receipt of the Application/Agreement and all required data supplied by the QREG customer, and all inspections completed to the Borough's satisfaction.

5. Designation of Borough Contact Persons for Technical Matters Relating to QREG Facility Interconnection - The Borough's Electric Superintendent (or his designee) shall be the designated point of contact for all technical matters related to these technical requirements.

6. Technical Guidelines for Parallel Operation of QREG Facilities - This subsection describes minimum requirements and procedures for safe and effective connection and operation of QREG facility. A QREG customer may operate 60 Hertz, three phase or single phase generating equipment in parallel with the Borough Electric System pursuant to an approved Application/Agreement provided the equipment meets or exceeds the requirements of these guidelines.

Approval to connect to the Borough system indicates only that the minimum requirements for a safe, proper interconnection have been satisfied. Such approval does not imply that the QREG customer's facility meets all federal, state, and local standards or regulations. The Borough is not responsible for activities or events on the customer's side of the interconnection, or for any consequence to other customers or to any person or property whether on the customer's side of the point of common coupling or in the Borough Electric System. The point of common coupling shall be the point where the electrical conductors of the Borough's System are connected to the customer's conductors, typically at the weatherhead for overhead services or line side of the meter base for underground services.

The requirements herein apply to the construction, installation and operation of a QREG facility.

A. Interconnection and Protection Requirements

1) The QREG customer's installation of generation and interconnection with the Borough Electric System must meet all applicable national, state, and local construction and safety codes.

2) The QREG customer's generator shall be equipped with protective hardware and software, subject to Borough approval, designed to prevent the QREG facility from energizing one of the Borough's de-energized circuits. The QREG customer's generator must automatically disconnect from the Borough Electric System if the Borough supplied electricity is lost, irrespective of the status or performance of other connected loads or other generators.

3) The QREG facility shall be equipped with the necessary protective hardware and software designed to prevent sustained parallel operation of the generating equipment with the Borough Electric System in the event that the generation system or Borough service voltage and frequency fluctuate from acceptable magnitudes.

4) The QREG customer shall be responsible for protecting its own generating and interconnection equipment in such a manner so that Borough system outages, short circuits, single phasing conditions or other disturbances

including zero sequence currents and ferroresonant over-voltages do not damage the QREG customer's generating equipment. The protective equipment shall also prevent excessive or unnecessary tripping that would adversely affect the Borough's service reliability or power quality to other QREG customers and customers.

5) The QREG facility and customer's interface protection schemes shall be continuously monitored, maintained and functioning and the QREG facility shall immediately disconnect from the Borough Electric System for any condition that would make the protection scheme inoperable.

6) The operating power required for the protection and control schemes for the QREG facility and the control power used to disconnect the QREG facility from the Borough must not be dependent on local Borough Electric System power, or must provide a "fail-safe" method to an "open" disconnected position upon loss of Borough supplied power.

7) Where multiple QREG units connect to the system through a single point of common coupling, the sum of the ratings of the QREG units are used to determine the applicability of these guidelines to the QREG facility.

8) Applicable circuit breakers or other interrupting devices at the QREG facility must be capable of interrupting the maximum available fault current at the site, including any contribution from the QREG facility.

9) The QREG customer shall furnish and install a manual AC disconnect device ("Customer Owned Generation Disconnect Switch(s)") which, when opened, shall have the effect of isolating the QREG facility from the Borough Electric System. The Customer Owned Generation Disconnect Switch(s) shall be located on the outside of the QREG Customer's building near the solar generation meter base, accessible to the Borough's personnel, and capable of being locked in the open position. The QREG customer shall follow the Borough's switching and tagging requirements.

10) The design, procurement, installation, and maintenance of the equipment at the QREG customer's site are the responsibility of the QREG customer and at the QREG customer's expense.

11) Any necessary enhancements or improvements needed within the Borough Electric System and/or at the customer sites to accommodate the parallel interconnection shall be at the QREG customer's expense.

12) The QREG customer has full responsibility and liability for the safe and proper operation and maintenance of its equipment and the power originating from its QREG facility.

13) The QREG customer must immediately cease parallel operation upon notification by the Borough if such operation is determined to be unsafe, interferes with the supply of service to other customers, or interferes with the Borough Electric System maintenance or operation.

B. Prevention of QREG Facility Generation Interference with Borough Electric System -To eliminate undesirable interference caused by operation of the QREG customer's generating equipment, the QREG customer's generator shall meet the following criteria:

1) **Voltage –**The generating equipment shall be operated in such a manner that the voltage levels on the Borough Electric System are in the same range as if the generating equipment were not connected to the Borough Electric System.

The QREG customer may reconnect to the grid when the system voltage stabilizes and returns to a normal range.

2) **Flicker -** The QREG customer shall not cause excessive voltage flicker on the Borough Electric System. This flicker shall not exceed the "Borderline of Irritation" curve, Fig. 10-3, as defined in IEEE Std 519-1992, "*Recommended Practices and Requirements for Harmonic Control in Electric Power Systems".* Lower levels of flicker may be required in areas where equipment such as computers and instrumentation are impacted.

3) **Frequency -** The operating frequency of the generating equipment shall not deviate more than the values noted below from the industry standard frequency of 60.0 Hz.

- Trip in 0.1 second for F<59.3 Hz
- Trip in 0.1 second for F>60.5 Hz

(Above times and voltages taken directly from IEEE 929)

Note: Trip time refers to the time between the abnormal frequency occurrence and the QREG facility disconnection from the Borough Electric System.

The QREG customer may reconnect when the system frequency returns to normal range and is stabilized.

4) **Harmonics -** Non-linear circuit elements such as inverters can produce harmonics. Per IEEE std 519, "*Recommended Practices and Requirements for Harmonic Control in Electric Power Systems"*, Table 11.1 (See Appendix 1), the total harmonic distortion (THD) voltage shall not exceed 5% of the fundamental 60 Hz frequency nor 3% of the fundamental for any individual harmonic as measured at the point of common coupling. In addition, the level of harmonic current that the customer is allowed to inject into the Borough Electric System shall not exceed that specified in Table 10.3 in IEEE Std 519 (See Appendix 1). Furthermore, any communication notch should be limited as defined by Table 10.2 in IEEE Std 519 (See Appendix 1). The preceding requirements apply to all types of renewable generation systems.

   The QREG customer is responsible for the installation of any necessary controls or hardware to limit the voltage and current harmonics generated by his equipment to within the defined acceptable levels.

5) **Power Factor** - The QREG facility must not adversely impact the power factor of the QREG customer site. Most inverters are designed to operate close to unity power factor. The operating power factor of the QREG facility shall be contained within 0.85 Lagging or Leading when output exceeds 10% of inverter rating (From IEEE 929-1999).

6) **Current -** Inverter systems should not inject DC current greater than 0.5% of rated inverter output in the AC interface point under either normal or abnormal conditions.

7) **Fault and Line Clearing -** The QREG customer shall automatically disconnect from the Borough Electric System during faults on the Borough's electrical system and upon loss of the Borough's electric source. The QREG customer may reconnect when the system voltage and frequency return to normal range and has stabilized. For generating QREG facilities of 10 kilowatts and below, the over/under voltage and over/under frequency settings described previously along with the anti-islanding provisions of IEEE 1547/UL 1746 inverters, should be sufficient to satisfy this provision.

8) **Automatic Reclosing -** The QREG customer is responsible for protecting its equipment from the effects of switching or automatic reclosing of the Borough's feeder circuit.

C. Inverter Type – Any DC generating QREG facility using an inverter(s) for interconnection with the Borough must use a non-islanding type inverter as defined in IEEE 1547, "*Standard for Interconnecting Distributed Resources with Electric Power Systems"* and UL 1741, "*UL Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources"* (or successor standards).

D. Suggested References - The following references (or their successors) can supply technical support and insight into the safe, reliable interconnection of a QREG facility with the Borough Electric System. These references should be reviewed by any individual or firm contemplating parallel operation of a QREG facility with the Borough Electric System.

IEEE C37.95-1989 - *IEEE Guide for Protective Relaying of Utility-Consumer Interconnections*

IEEE Std 1001 (1988) - *IEEE Guide for Interfacing Dispersed Storage and Generation Facilities with Electric Utility Systems*

IEEE Std 929 - *IEEE Recommended Practices for Utility Interface of Photovoltaic (PV) Systems*

IEEE Std 519 -1992 - *IEEE Recommended Practices and Requirements for Harmonic Control In Electrical Power Systems*

IEEE 1547 - *IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems*

UL 1741 - *UL Standard for Safety Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources*

Appendix 1

Selected Tables from IEEE Std. 519-1992

Recommended Practices and Requirements
For Harmonic Control in Electric Power Systems

Figure 10-3 Maximum Permissible Voltage Fluctuations

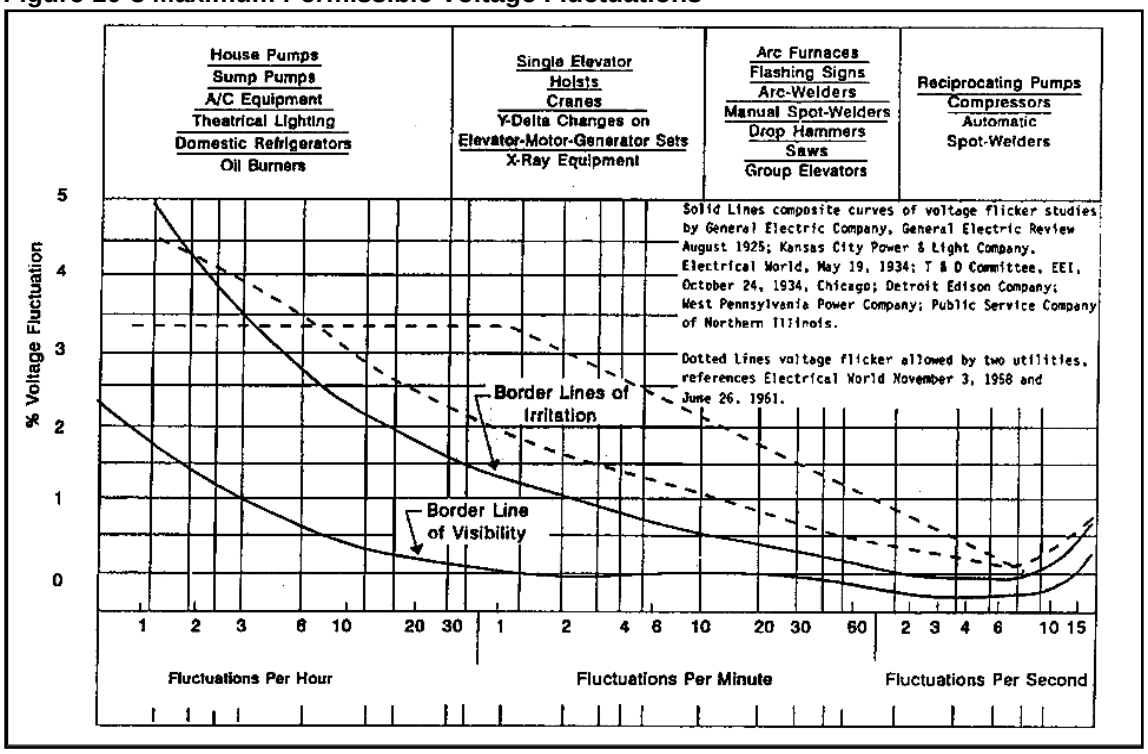

Table 10-2—Low-Voltage System Classification and Distortion Limits

	Special Applications*	General System	Dedicated System†
Notch Depth	10%	20%	50%
THD (Voltage)	3%	5%	10%
Notch Area (A_N)‡	16 400	22 800	36 500

NOTE — The value A_N for other than 480 V systems should be multiplied by V/480

*Special applications include hospitals and airports.
†A dedicated system is exclusively dedicated to the converter load.
‡In volt-microseconds at rated voltage and current.

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Table 10-3—Current Distortion Limits for General Distribution Systems (120 V Through 69 000 V)

Maximum Harmonic Current Distortion in Percent of I_L						
	Individual Harmonic Order (Odd Harmonics)					
I_{sc}/I_L	$h<11$	$11\le h<17$	$17\le h<23$	$23\le h<35$	$35\le h$	TDD
<20*	4.0	2.0	1.5	0.6	0.3	5.0
20<50	7.0	3.5	2.5	1.0	0.5	8.0
50<100	10.0	4.5	4.0	1.5	0.7	12.0
100<1000	12.0	5.5	5.0	2.0	1.0	15.0
>1000	15.0	7.0	6.0	2.5	1.4	20.0

Even harmonics are limited to 25% of the odd harmonic limits above.

Current distortions that result in a dc offset, e.g., half-wave converters, are not allowed.

* All power generation equipment is limited to these values of current distortion, regardless of actual I_{sc}/I_L.

where
I_{sc} = maximum short-circuit current at PCC.
I_L = maximum demand load current (fundamental frequency component) at PCC.

Table 11-1—Voltage Distortion Limits

Bus Voltage at PCC	Individual Voltage Distortion (%)	Total Voltage Distortion THD (%)
69 kV and below	3.0	5.0
69.001 kV through 161 kV	1.5	2.5
161.001 kV and above	1.0	1.5

NOTE — High-voltage systems can have up to 2.0% THD where the cause is an HVDC terminal that will attenuate by the time it is tapped for a user.

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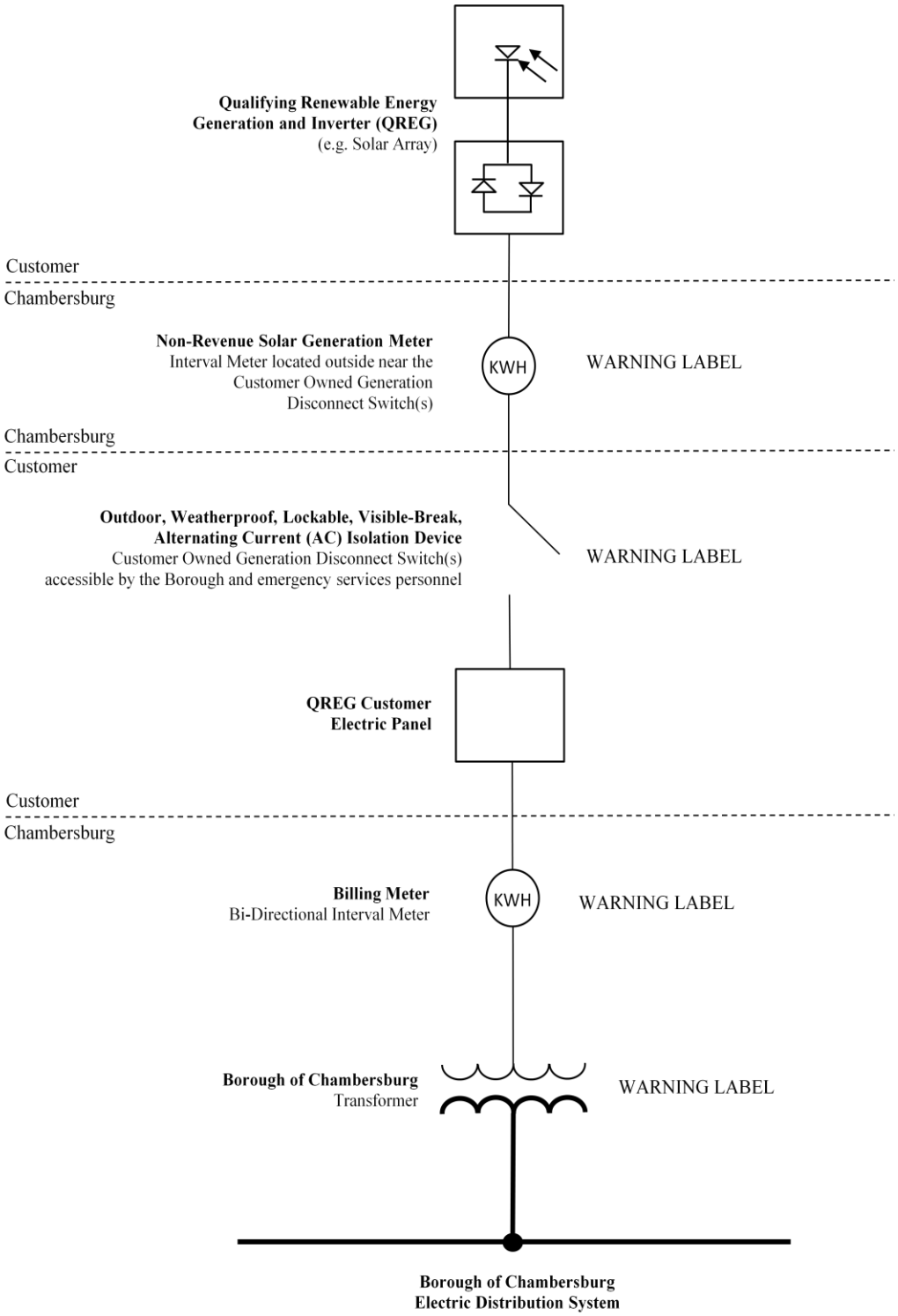
Appendix 2

Illustrative Single Line wiring Diagram of QREG Facility and the Interconnection with the Borough Electric System



Note: The diagram is provided for illustrative purposes only, and does not represent a complete or universal depiction of every QREG facility.